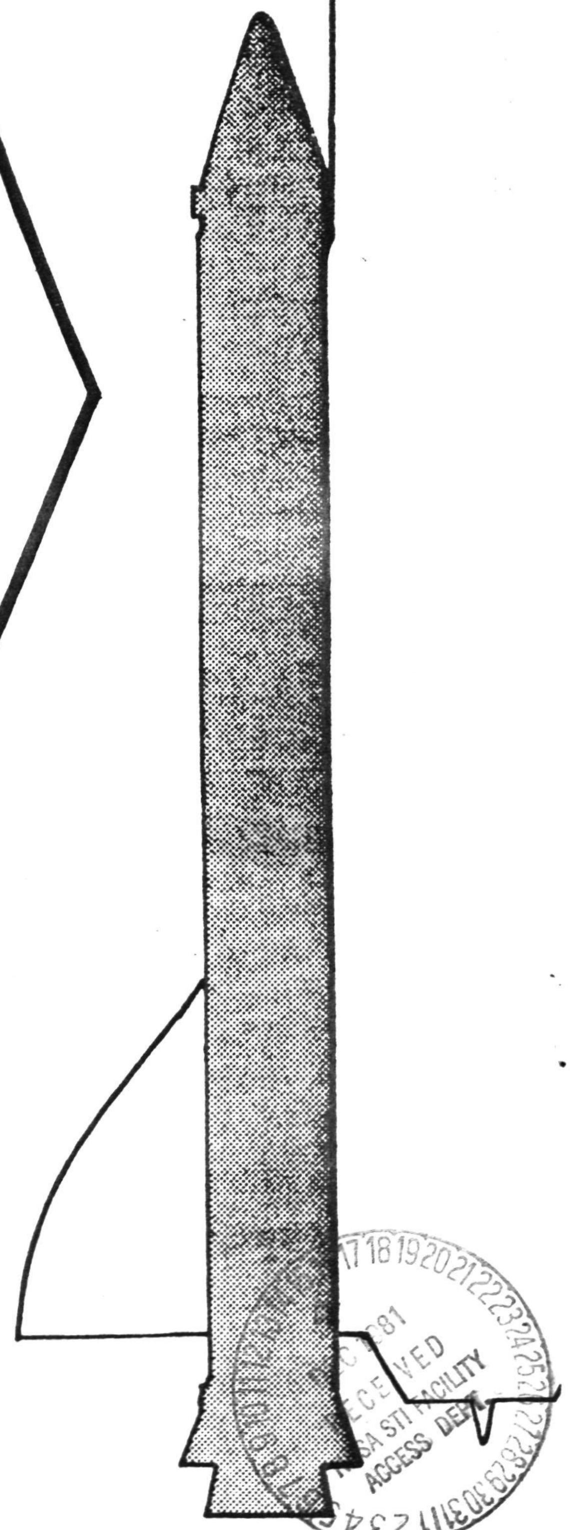
G-402



DESIGN REQUIREMENTS FOR SRB PRODUCTION CONTROL SYSTEM

FINAL REPORT

VOLUME I

STUDY BACKGROUND AND OVERVIEW

SUBMITTED BY:

A.T. KEARNEY, INC.

DESIGN REQUIREMENTS FOR THE SRB PRODUCTION CONTROL SYSTEM

VOLUME I

STUDY BACKGROUND AND OVERVIEW

TABLE OF CONTENTS

I - BACKGROUND

PRESENT SITUATION

The space shuttle, America's newest space project, is designed to make space travel an economical concept. In terms of economies, it is often compared to the first phase of commerical air travel.

This shuttle will be the most sophisticated flying machine ever built--half space ship, half airplane. It consists of three major elements, the spacecraft (orbiter), solid rocket boosters (SRBs) and the external fuel tank (ET). The economies associated with this space shuttle are principally arrived at through the reusability of two of these three major elements, the solid rocket boosters and the orbiter craft. In addition, advance booster technology has also contributed to the economies associated with lifting payloads into space.

There are a number of organizations, both within and outside of NASA which are involved in the space shuttle project. Some of the major ones are reviewed in the paragraphs which follow.

(a) NASA/Marshall Space Flight Center (MSFC)

NASA/MSFC has the overall mission responsibility for the space shuttle program, including all three major elements, the orbiter, the solid rocket boosters (SRB) and the external tank (ET).

This responsibility includes the coordination of efforts for the production and assembly of these three elements and the hundreds of contractors and vendors involved. MSFC has developed an organization structure which assigns responsibility for each of the major elements to a unit within the organization and maintains overall integration responsibility in the Shuttle Projects office. These integration responsibilities are especially crucial, given that the efforts of contractors and vendors are taking place in different locations around the country. For example, the external tank is produced at the Michoud Assembly Facility in Louisiana, the solid rocket motor (SRM) is produced in Utah, the orbiter is produced in California, and the segments and major assemblies are assembled and mated in Florida. Each of the contractors and vendors, therefore, have to aim towards the same launch date. MSFC is responsible for ensuring that this takes place.

(b) NASA/Kennedy Space Center (KSC)

The final assembly and launch of the space shuttle takes place at Kennedy Space Center. This includes the final assembly of the solid rocket boosters, final preparation of the orbiter for flight, and the mating of the orbiter and the SRB's to the external tank, as well as the launch process. KSC is also responsible for the retrieval of the solid rocket boosters and will serve as the landing area for the orbiter craft when it returns to earth.

Much of this assembly process takes place in the Vehicle Assembly Building (VAB) at KSC. This includes the stacking of the solid rocket boosters and the mating of the orbiter and the solid rocket boosters to the external tank. Other activities take place in other facilities around KSC, including Hanger N, which serves as a receiving area for USBI, Hanger AF, which serves as the retrieval and disassembly area for the SRB's, and the orbiter processing facility to which the orbiter is returned and readied for another flight. As will be seen, this dispersion of activities will have major implications for the design of the automated production control system.

(c) Vandenberg Air Force Base (VAFB)

Department of Defense missions are scheduled to take place some time in 1984 using the VAFB launch facilities. VAFB assembly requirements will be quite similar to the KSC configuration except for a few differences in the flow of hardware in the final assembly. It will also require the installation of liquid boost modules to enable the VAFB-launched vehicles to attain polar orbit rather than the easier equatorial orbit.

(d) SRB Contractors

The development of the SRB is managed by the MSFC/SRB project office. The responsibility for the assembly of the SRB is divided between MSFC and KSC. Thus, the assembly is done under two different contracts.

MSFC awarded the contract for the SRB motor development to Thiokol Corporation's, Wasatch Division, Brigham City, Utah. Their contract includes the design and production of motors for ground tests, structural tests, and flight.

MSFC elected to develop the booster subsystems, other than the motor, as an in-house project. Hundreds of subcontractors are supplying parts, assemblies, and materials for SRB development.

The final major procurement was made in 1976 when the booster assembly contractor, United Space Booster, Inc. (USBI), was awarded a dual contract from MSFC and KSC for the assembly, check out, launch, recovery, and refurbishment of the booster at KSC.

STUDY OBJECTIVES AND SCOPE

(a) Primary Objectives

Kearney: Management Consultants was awarded a contract by MSFC with three primary objectives:

- Identify and document automated production control system requirements.
- Identify commercially available software packages and appropriate hardware.
- Develop an implementation plan for the automated production control system.

(b) Specific Guidelines

The following specific guidelines for this study were developed to meet these primary objectives:

1. Conduct an overview of the total USBI/SRB production (assembly) operation.

2. Determine the specific information requirements concerning SRB production of both NASA/MSFC and USBI. Further, identify the various reports necessary to support managerial planning and control.

3. Determine the data requirements of each department through surveys of the functional operating departments. Identify if necessary, information flows and reports between the various operating departments which are needed to support the automated production control system.

4. Determine the proper format for an integrated data base system. Especially examine the MSFC drawing number system to determine whether total conversion of this system to Mil Standard 100 is required prior to loading the master data file.

5. Examine the implications for the automated production control system of supporting production facilities at both KSC and VAFB.

6. Determine the implications for the automated production control system for the unique environment posed by SRB production. These unique requirements include accounting for

part attrition, changes to the mission model, design changes and extraordinarily long lead times.

7. Identify the degree to which the production control system should be capable of tracking hardware items through the entire cycle of initial build-up, stacking, launch, flight, recovery and refurbishment.

8. Evaluate the means to, and feasibility of, a production control system that can selectively chose from stock, by serial number, the correctly refurbished hardware item that will allow the available hardware to "grow old together".

9. Evaluate other management information systems software requirements currently in place to support the SRB activities and provide the degree of consistency with these systems which is feasible.

10. Evaluate parameters of the required main frames and support hardware to include, but not be limited to:

(a) Size

(b) Memory

(c) Processing speed

(d) Transmission protocol

(e) Average access time

(f) Mass storage

(g) Executive systems requirement

(h) Data management and software system requirement

(i) Communication multiplexer network

(j) Communication line speed

(k) Communication multi-drop requirements

(l) Data set requirements

(m) Peripheral support equipment

11. Identify the type, location, number and peripheral requirements of interactive CRT display and other terminals required.

12. Determine the system security requirements.

13. Identify requirements for back-up processing methods to be used in the event the computer and/or terminals become inoperative.

14. Identify the period of time during a 24-hour period that normal access to the computer data base will be required. Further identify system load level requirements.

15. Identify the work load volumes anticipated at each remote terminal.

16. Determine and recommend the best suited commercially available, field proven, software package for the automated production control system. Determine the changes/modification required for this particular application. Determine the programming skills and manpower levels required to support such changes/modifications.

17. Determine the appropriate hardware requirements to support the software package selected. Recommend the most cost effective location for the hardware, taking into consideration existing NASA facilities.

18. Develop a phased implementation schedule for the automated production control system that will be consistent with the launch rate.

19. Develop rough order of magnitude (ROM) costs and manpower requirements to:

(a) Implement the automated production control system.

(b) Operate the automated production control system.

These guidelines, which are consistent with the primarly objectives of the study outlined above, guided the method of approach to this study. These guidelines also helped define the scope of the study which is outlined below.

(c) Scope

The scope of this study was defined both by the above guidelines and by organizational boundaries within NASA and USBI.

Within the NASA organization, the scope of the study is limited to groups within MSFC and KSC which are directly involved with the production of the solid rocket boosters. The only interface with other shuttle organizations within MSFC and KSC is at

the master schedule level and the aisle transfer schedule level. In addition, as defined from the guidelines above, this system should be able to accommodate production and assembly of SRB's at Vandenberg Air Force Base in 1984, if it is so desired.

Within USBI, the scope is also defined by the organization. The automated production control system has been developed to meet specific management and production needs within the USBI organization, as well as within the NASA organization. Thus, the automated production control system is designed to meet the needs of USBI's functional organization at the Huntsville location and USBI's departmental organization at KSC.

STUDY RATIONALE

Our study approach was based upon a rationale developed through other studies of this type. A specific sequence of analytical steps was proposed and followed to obtain the best results with a minimum effort and cost. These steps, and the rationale behind them, are described in the paragraphs which follow.

(a) Define Existing Operations

The first requirement in a study of this size and importance is to understand what the existing system requirements are and to

what extend these requirements are being fulfilled. Therefore, two specific tasks were undertaken:

1. Define the existing system of production control in terms of:

- flowcharts
- system narratives
- reports
- critical decision trees

2. Define actual practices in place to support the existing systems, in terms of:

- the managerial/supervisory control
- basic production and disciplines
- overall effectiveness

(b) Determine Current Practices

The next step within this process is to examine the current system as it is operating to determine any shortfalls in operating practices or procedures. This will allow a more realistic assessment of the current system and of the needs to be taken into account in the future system.

(c) Develop Operating Recommendations

On the basis of our examination of current practices within a SRB assembly environment, recommendations were developed

regarding short-term and intermediate term operating practices which should be adjusted. These operating disciplines, once in place, will serve to support the automated production control system as it is implemented. Many of these recommendations will be part of the early phases of the implementation plan.

(d) Identify System Requirements

Management needs for the effective control of the assembly of the SRB are then translated into business system requirements. This step, therefore, results in a conceptual business system which is defined to the degree necessary for development of computer systems specifications.

(e) Develop Computer System Specifications

Based upon the results of the previous step, detailed computer system specifications are developed in accordance with the parameters identified in the guidelines presented above.

(f) Select Software Package

Commercially available and field proven in software packages are then examined in a light of the business system requirements and computer systems specifications developed in the previous steps. Also, included as part of this task is a determination of

the necessary modifications in the software package to meet the requirements posed by the unique SRB assembly environment.

(g) Identify Hardware Requirements

The next step in the study process is to identify the hardware requirements based on the software packages identified in the previous step. Also included in this step is a review of NASA facilities to determine the suitability of existing hardware to support the production control system.

(h) Develop Implementation Schedule

The final step in this study is to develop an implementation schedule that is consistent with NASA/MSFC and USBI requirements. In addition, manpower requirements and rough order of magnitude costs are provided for the modification and installation of the software selected. Estimates are also developed regarding the timing and cost of the computer hardware installation.

METHOD OF APPROACH

In line with the rationale developed in the previous section, the flowchart in Figure I-1 presents the study method of approach. This method of approach is described in the paragraphs below.

(a) Determine Existing Practices

The first phase of this study involved an on-site review of the existing practices and procedures in the SRB production. This included an examination of current organizational relationships, responsibilities, information flows, reporting mechanisms, etc. Also included in this step was an overall view of the assembly process.

(b) Determine System Requirements

A determination of system requirements involved both examining existing system requirements and future system requirements. A determination of existing system requirements included an examination of both existing information flows and information flows which do not exist but were considered necessary.

Future system requirements were identified based on the needs of an automated production control system. The principal focus of this task was a determination of required information flows by department, organization, and location.

(c) Develop Business System Requirements

The information flow requirements, and other system requirements developed in the previous step, were then translated into business system requirements in terms of flowcharts and narratives.

(d) Develop Computer System Specifications

The business system requirements developed above were converted to detailed computer systems specifications through the following steps:

- Develop high level system flowcharts
- Develop data dictionary
- Develop system volume estimates
- Develop network architecture requirements
- Develop system security requirements
- Develop system contingency requirements
- Evaluate existing information systems
- Develop conceptual integrated system model.

Thus, the second phase of this study consisted of the identification of business system requirements and the computer system specifications to meet those requirements. Appropriate software and hardware technology to meet these requirements can now be identified in the third phase.

(e) Identify Computer Packages

In this task, a listing of available software packages which might be appropriate for use in the SRB production environment was developed and the list was subjected to an initial screening process to narrow it to the most likely four or five packages.

The following steps were involved in this task:

- Develop a comprehensive listing of potential software packages.

- Develop and distribute a vendor survey regarding the specific systems information on each package identified.

- Analyze each package on preliminary basis to narrow the list of potential packages to four or five.

(f) Select Software Package

The software packages identified in the previous step were then subjected to the more rigorous criteria developed in the business system requirements, the computer systems specifications, as well as the criteria outlined in the guidelines previously presented. The steps involved here included:

- Meet with vendors to further investigate specific features of each package.

- Finalize software package selection based upon further analysis and on-site trips to line installations where selected packages were in operation.

(g) Determine Hardware Requirements

Upon selection of a specific software package, Kearney developed finite computer hardware requirements and configuration for the proposed production control system. The specific steps

involved in this task were as follows:

- Determine the appropriate hardware configuration which can be used in conjunction with the selected software package.

- Conduct an audit of NASA computer facilities to determine the suitability of these facilities to handle the selected software package.

- Contact hardware vendors to determine hardware availability. The availabilty of hardware must comply with NASA/MSFC and USBI time requirements.

(h) Determine Required Modifications

Upon selection of the appropriate software package, necessary modifications to the software were defined based upon the unique requirements of the SRB assembly environment. These modifications were reviewed with the software vendor to determine their feasibility.

(i) Select Hardware/ Software Combination

The result of the previous steps is an "ideal" hardware and software combination for the SRB assembly environment. This includes the selection of the software, the definition of required modifications and the selection of the hardware which is necessary for the selected software package. At this point an implementation plan was developed.

(j) Develop Implementation Work Plan

Based upon the various constraints of hardware leadtime, software modification time, hardware installation time, and the capabilities of NASA/MSFC and USBI to absorb change, a time-phased implementation work plan was developed for the system. The following steps were involved in this task:

- Identify system implementation constraints
- Recommend an implementation organization
- Develop a time-phased work plan for implementation

(k) Develop Rough Order of Magnitude Cost

The information developed regarding necessary implementation resources and operation resources for the automated production control system was converted into estimates of necessary investments in terms of manpower and costs.

SUMMARY

The SRB assembly environment is unique in terms of the constraints it places upon an automated production control system. Many of these unique requirements will be reviewed in the remainder of this document, especially in the description of the business system.

The remainder of this report describes the existing business environment and the changes which might be required in it, describes

the manner in which an automated production control system can be related to the current environment, describes the business system which was generated for the SRB assembly and the computer system which meets these business system requirements. It further describes the software selection process and the modifications required to the software recommended, as well as the hardware and configuration requirements necessary to support the system. The second volume of this report details an implementation work plan for the time-phased implementation of the automated production control system.

II - OVERVIEW

THE CURRENT ENVIRONMENT

The Solid Rocket Booster is composed of six major elements or subsystems.

(a) Solid Rocket Motor

This subsystem is the main propulsive element providing thrust to the STS from ignition to SRB staging. The primary configuration needed for one SRM, is a forward motor segment, two center motor segments, an aft motor segment, an aft exit cone assembly, and a nozzle ordnance ring. Due to interchangeability and replaceability requirements, a set of SRMs will be cast in matched pairs from the same propellant lot.

The responsibility for SRM propellant casting and loading is that of Thiokol in Utah.

(b) Structures

The structural subsystem must provide for the necessary support of the ET and Orbiter from mating in the VAB to launch from the pad complex. In addition, the structural subsystem must transfer the thrust provided by the SRBs to the Orbiter and ET during launch, as well as provide the structural housing for the other components of the SRB.

The major components of the structural subsystem are:

- Aft Skirt.
- SRB/ET Aft Ring and Attachments.
- Systems Tunnels.
- Forward Skirt.
- Forward Ordnance Ring.
- Nose Assembly.

(c) Thrust Vector Control

This subsystem aids in providing maneuverability (yaw, pitch, and roll) required by the Orbiter Command System. The two major components, mounted in the aft skirt are:

- Hydraulic Power Supply.
- Servoactuators.

(d) Separation Subsystem

This subsystem provides for the safe separation of an SRB from the ET during SRB staging. This staging occurs approximately two minutes after launch. The major components of this subsystem are:

- Booster Separation Motors.
- Release System.
- Sensors.
- Separation Bolts.

(e) Recovery Subsystem

The booster recovery subsystem provide for the descent, parachute separation, and location elements which are used in the search and retrieval operations. The major components of these subsystems are:

- Location Equipment.
- Pilot and Drogue Parachutes.
- Main Parachutes.

(f) Electrical and Instrumentation

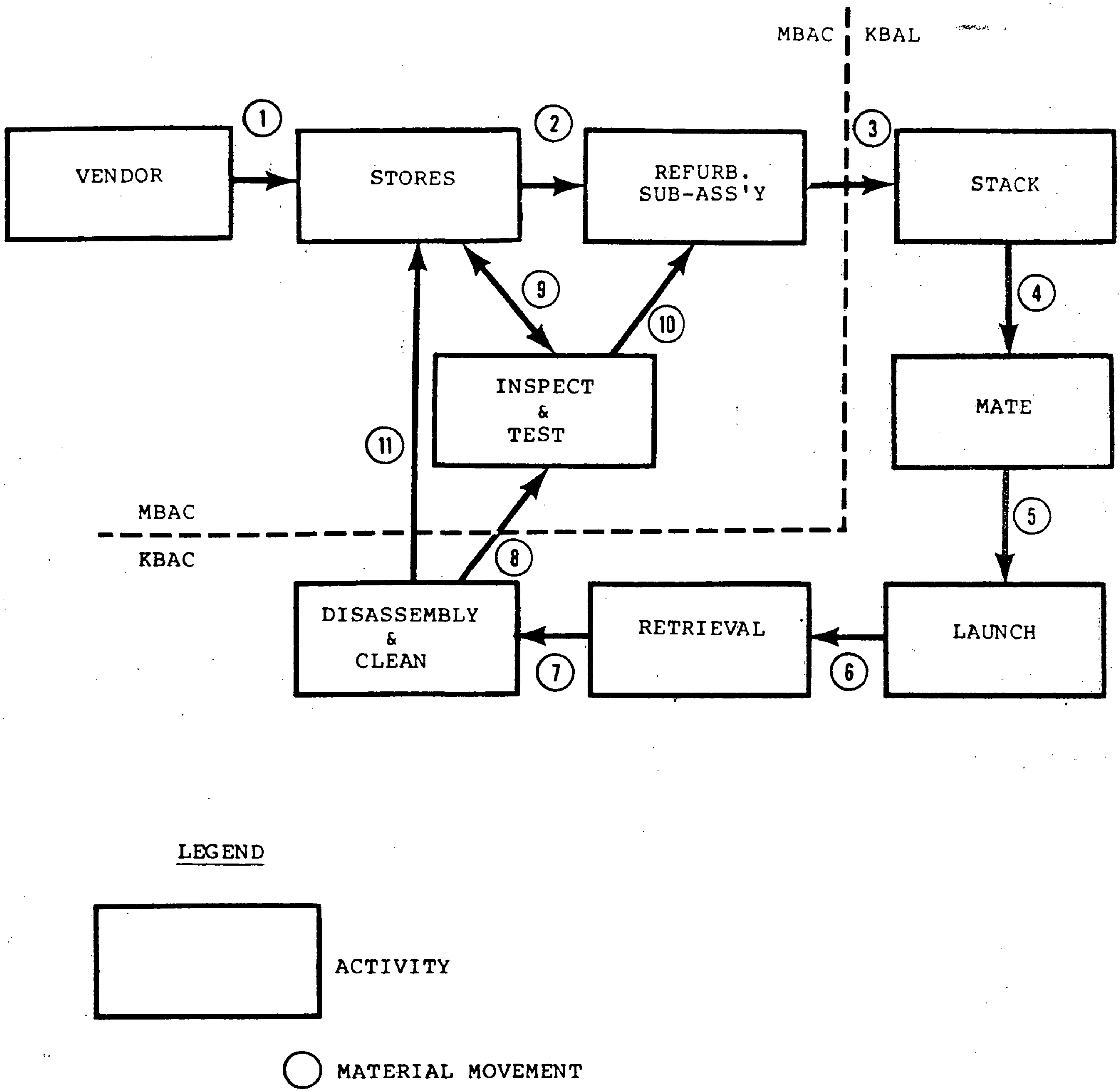
This final subsystem is divided into two functional subsystems. One, the Ascent System, is used from prelaunch until SRB/ET separation. The second, the Recovery System, begins operating prior to the SRB/ET separation and remains operational until after splashdown. These subsystems consist of numerous major components.

GENERAL DESCRIPTION OF THE SRB MISSION

Figure II-1 shows the SRB material flow overview, from original acquisition of parts from vendors through the inspection and testing activities, leading to reuse of the parts in subsequent missions. The description which follows includes numbered movement types from one primary activity in the material flow to another, in order to define Kearney's perception as to what generally will be required as STS missions start to approach the 40 per year mark. Based on our observations at the Kennedy

FIGURE II-1

SRB - MATERIAL FLOW OVERVIEW



Space Center during September and October 1980, specific locations are named in the following narrative that were used during this period of our observation, even though these specific locations may not currently be used, or may not be used later in the program. This is done so that a "facility baseline" can be achieved and used in subsequent sections of this report.

(a) Vendor

Vendors and subcontractors supply parts, assemblies, subassemblies, and other materials for the first initial flights. It is estimated that between 10 and 12 complete flight sets will be acquired over the next several years. In addition, attrition rate (both forecasted and actual) will require additional receipts from vendors, as will recovery loss rates of individual components.

(b) Stores

Movement (1) indicates the physical movement of material from vendors to a stores area. In reality, material is received at KSC through a base control receiving area, from which it is directly transferred to the SRB stores area (Hangar N). This receiving area physically inspects, and in some cases tests materials, and stores them until needed in the Refurbishment Subassembly Facility or some other area.

When such requirements are identified, materials are transferred from the stores area to the RSF (VAB Lo Bay) as shown by movement (2).

(c) Refurbishment/
Subassembly

Rather than being transferred directly to the "shop floor" in the RSF however, most material is transferred to a small material storage area (1N4) where it is controlled and stored until parts kitting and/or material requisition documents transfer the material to the RSF shop floor. This material is used in the initial (first time) subassembly and assembly of major components. These major components consist of the following:

- Nose Cone.
- Frustum.
- Forward Skirt.
- Aft Skirt,
- Numerous parts kits (with about 8,000 parts).

Upon completion of these major components and the kitting of the numerous parts as well as a series of NASA (KSC) "buy-offs", movement (3) takes place.

(d) Stack

Movement (3) is known as "aisle transfer" and differentiates between the MBAC and KBAC contracts within USBI. The stacking of the SRB consists of joining the major components transferred from the RSF, e.g., Nose Cone, Forward Skirt, etc., with the major segments of the SRM. This stacking takes place on the Mobil Launch Pad (MLP) in a serial operation with the aft skirt first, followed by the aft center rocket motor segments, forward center rocket motor segments, and so on, until the SRBS are completed.

Various seal tests and alignment checks are performed after stacking operations are complete. In addition, various tunnels, cables, covers, etc., will be installed and tested.

(e) Mate

The mating operation involves the movement of the ET to the MLP for attachment to the SRBs as well as the movement of the Orbiter to the MLP for attachment to the ET. During and after completion of mating, numerous tests and checks are made to insure component integrity.

(f) Launch

Upon completion and thorough testing of the mated STS, movement (5) takes place. This is the "roll out" of the MLP with the STS from the VAB-high bay to Pad 39 complex (A or B). During the preflight period, various system lines are charged, additional ordnance is added, and ET fueling takes place. At the time of the launch, the pair of SRBs ignite, adding in excess of 2.5 milion pounds of thrust per SRB. The ignition and burn takes place for approximately two minutes at which time the SRBs are separated from the ET and are parachuted back to earth.

(g) Retrieval

Movement (6) involves the deployment of numerous parachutes to "softly" land the SRBs in the water. Retrieval of the boosters, frustums, and parachutes will be accomplished by using two UTC ships, the Liberty and the Freedom. During the retrieval, the boosters will be verified to be safe, and booster dewatering will

be accomplished by the use of pumps. The frustums and parachutes will be loaded aboard the vessels for transport back to KSC.

(h) Disassembly and Cleaning

Movement (7) is the towing of the boosters, one per vessel, back to KSC for cleaning and reuse. Upon arrival at the Disassembly Facility (Hangar AF), the parachutes and frustums are off-loaded from the vessels. In addition, the boosters and the SRB structures undergo a gross wash. The structures will then be moved to the disassembly facility for disassembling into major asemblies of solid rocket motor segments (4) aft skirt, and forward skirt.

The SRM segments will be washed and dried and prepared for shipment to Thiokol for refurbishment. The frustum, aft skirt and forward skirt will be stripped of insulation, washed and dried and prepared for transport to the RSF for inspection and testing (movement (8)). At this point in the material flow, we recognize the possibility of moving components to a stores area, due to unanticipated damage on one or all of the components, back-up in the inspection and testing area, or other reasons. This movement (movement (11)) would result in components being inventoried in a stores area (perhaps similar to Hangar N) in a status which indicates that inspection and testing has not been completed.

(i) Inspection and Testing

This activity, performed in the RSF, involves the testing of Structural, TVC, Recovery, Electrical and Instrumentation subsystems. The objective of these tests is to determine if any out-of-tolerance conditions exist, down to the Line Replaceable Unit (LRU) level. Individual module tests are performed, and the results of these tests determine what refurbishment will be required to make the component, LRU, module, subassembly, or assembly flightworthy. The next "movement" (movement (10)) is to the actual refurbishment area, which may in fact be in the identical location used for testing and inspection.

We recognize also, the potential movement of material to a stores area after inspection and testing, but prior to actual refurbishment and subassembly (movement (9)), due to uncertain disposition of the material, back-up in the refurbishment area or one of several other reasons. This potential movement creates the need for components to be inventoried in a stores area in a status which indicates that inspection and testing have been completed, or partially completed, and that flightworthiness has or has not been determined. As a result of this condition, as well as the condition where components have been moved to a stores area directly from Disassembly and Cleaning, movement (9), as shown on Figure II-1 can in fact be a two-way movement, e.g., from Inspection and Testing to Stores or from Stores to Inspection and Testing.

(j) Refurbishment and Subassembly

At this point in the material flow, it is assumed that components flown on previous flights will be entering the Refurbishment and Subassembly activity and that new parts and "used" parts may be co-mingled in the subassembly of the major components discussed before. The actual refurbishment and subassembly activity will be performed simultaneously, again with final "buy-off" and aisle transfer taking place upon final completion.

A more detailed schematic of the process is depicted in Exhibit II-1, Exhibit II-2, and Exhibit II-3, at the end of this section.

USBI ORGANIZATION

Operational activity performed at KSC by USBI center around two separate contracts with NASA. The MBAC (Marshall Booster Assembly Contract) portion of the operation is involved in the design, development and operation of assembly, testing, repair and replacement of the major modules used in the SRB. The KBAC (Kennedy Booster Assembly Contract) portion of the operation is involved with the stacking, testing, mating support, launch support, recovery, disassembly and cleaning of the SRBs. In addition, the cleaning and refurbishment of the parachutes are included in the KBAC portion of the contract.

In order to provide discrete operating responsibility and effective support across the two NASA contracts, USBI has

developed a KSC organization which is shown in schematic form in Figure II-2. In addition, a Huntsville support organization has been developed to support the design, development and data tracking requirements of the Booster Assembly Contract.

The following descriptions provide a general overview of responsibilities for each of the four major USBI organizational units at KSC.

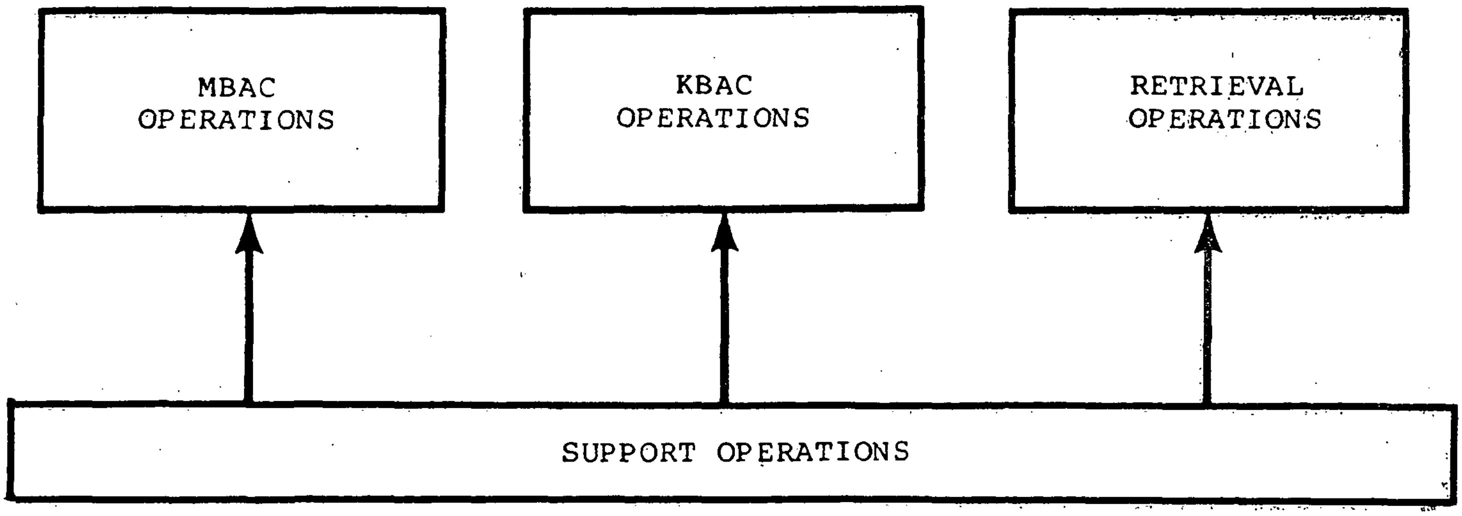
(a) MBAC
Operations

The prime responsibility of the MBAC Operations fuction is for the initial assembly, refurbishment, and subsequent reassembly of components and materials required for the "manufacture" of the major modules transferred to KBAC at aisle transfer. These major modules are, nose cones, frustums, skirts (both forward and aft) and numerous parts associated with the subsequent stacking operation in KBAC. In addition, MBAC has responsibility for the inspection and testing of used flight hardware in order to determine future flightworthiness potential.

Currently, the MBAC Operation activities are centered around various Work Authorization Documents (WADs) which are used to schedule work by departments (electrical, mechanical, etc.). MBAC operations then assigns work by skill level within a department. WADs are also used to call out of stores, various components and materials for assembly or fabrication. Using these WADs in this manner is similar to manufacturing routing sheets which include parts lists.

FIGURE II-2

USBI ORGANIZATION AT KSC



During the course of its refurbishment and subassembly activities, MBAC is required to interface with numerous organizations providing direct or indirect support to the operation. This interface is one of the key elements in the daily activities that have been addressed in the business requirements described in Section III of this report.

(b) KBAC Operations

The KBAC Operations function is responsible for SRB stacking, mating and launch support, recovery, and disassembly and cleaning. As with MBAC, KBAC uses various work authorization documents in order to schedule and perform the required work.

KBAC is divided into two primary branches; SRB Processing Branch and SRB Engineering Branch. The SRB Processing Branch consists of Launch Operations, involved primarily with pre-launch and launch activities; Post-Launch Operations, involved with cleaning and disassembly; and finally Technician Operations. The SRB Engineering Branch consists of Mechanical Systems Engineering, Electronic Systems Engineering, and Software Data Bank.

(c) Retrieval

The overall requirements of this department are the acquisition and outfitting of retrieval vessels, the development of a retrieval team, and the management and operating control for the equipment testing, and actual SRB retrieval. This department is composed of Marine Operations which is responsible for the ships

UTC Liberty and UTC Freedom; and Retrieval Equipment Operations and Maintenance.

(d) Support Operations

The Support Operations Department is divided into four organizations which directly interface with the above mentioned departments.

1. Logistics. This organization is responsible for Material Control, Supply Support, and Technical Training, Material Control involves the scheduling and tracking of SRB flight hardware, GSE and material. In addition, Material Control provides liaison with other organizations (NASA and other contractors) for shipping, receiving and handling of such material. Supply Support is responsible for the coordination and expediting of material and equipment needed to support assembly operations schedules. In addition, inventory control of critical flight hardware and GSE is maintained by this organization. Technical Training is responsible for personnel training and certification as well as maintaining historical files of same.

2. Operations Control. This organization is responsible for most of the functional activities typically associated with a Production Control department in a manufacturing operation. These activities include the following:

- Manufacturing Resource Planning.
- Production Scheduling.
- Operations Planning and Scheduling.
- Manufacturing Documentation.
- Operations Documentation.

3. GSE Maintenance. The GSE Maintenance organization is responsible for the development and preparation of maintenance documentation for such things as preventive maintenance, inspection, calibration, adjustment and cleaning of GSE, SE, and STE. In addition, this group is responsible for the development and administration of the subsytem used for maintenance recall and normal maintenance activities.

4. Configuration Management. This final organization within the Support Department is responsible for manufacturing configuration control and configuration accounting. Manufacturing configuration control is responsible for such things as the coordination of ECRs, ESRs, and FECs, as well as the development and preparation of configuration status. Configuration accounting is responsible for maintenance and operation of the technical data center as well as the generation of "as built" records as actual SRB assembly takes place.

(e) Other Departments

Numerous other departments, both in Huntsville and at KSC, provide direct or indirect support for the four key operational departments identified above. These departments include Reliability and Quality Assurance which is responsible for quality engineering, inspection, and quality data center operations; Safety which is responsible for industrial safety and systems safety; as well as a host of other engineering and business support departments.

PRODUCTION CONTROL SYSTEM OVERVIEW

In a highly complex environment such as the SRB subassembly/refurbishment process it is necessary for a production control system to perform certain functions. At the broadest level, these functions may be grouped into four categories:

- Planning the program.
- Scheduling the plan.
- Reporting the schedule execution.
- Monitoring performance.

However, these functional categories are not a one-time activity but instead are continuous and on-going throughout the life of the project.

A more comprehensive method of describing the functions of an automated production control system within the SRB environment is to group these specific functions into discrete categories and relate these specific functions to the existing USBI organization. The following APC function groups have been identified for inclusion in the recommended conceptual system:

- Resource Planning
- Quality Assurance and Reliability
- Design Engineering/BOM Maintenance
- Process Engineering/Routing Maintenance
- Production Control
- Inventory Control
- Dispatching

- Operations Control
- Performance Reporting.
- GSE Preventive Maintenance
- Purchasing and Subsystems Technical Support
- Production Costing
- Material Handling
- Data Processing Support.

Each of these functional groups contains several specific functions which must also be included in an automated production control system. Figure II-3 shows each functional group divided by specific functions. The current USBI organization is also indicated and a correlation is made between each specific function in an automated production control system and the USBI organizational unit that currently performs the function or is expected to do so in the future. Functions which do not appear to be covered by the USBI organization at the present time are indicated in the column titled "USBI GAP".

In Section IV of this report, a conceptual business system is described in detail. This conceptual system consists of several subsystem modules which are necessary in order to support the business system requirements. Figure II-4 shows the relationship between each specific function of an automated production control system and the subsystem module in the conceptual system which will perform that function.

Figure II-3

AUTOMATED PRODUCTION CONTROL SYSTEM

CURRENT ORGANIZATION - APC FUNCTION CORRELATION MATRIX

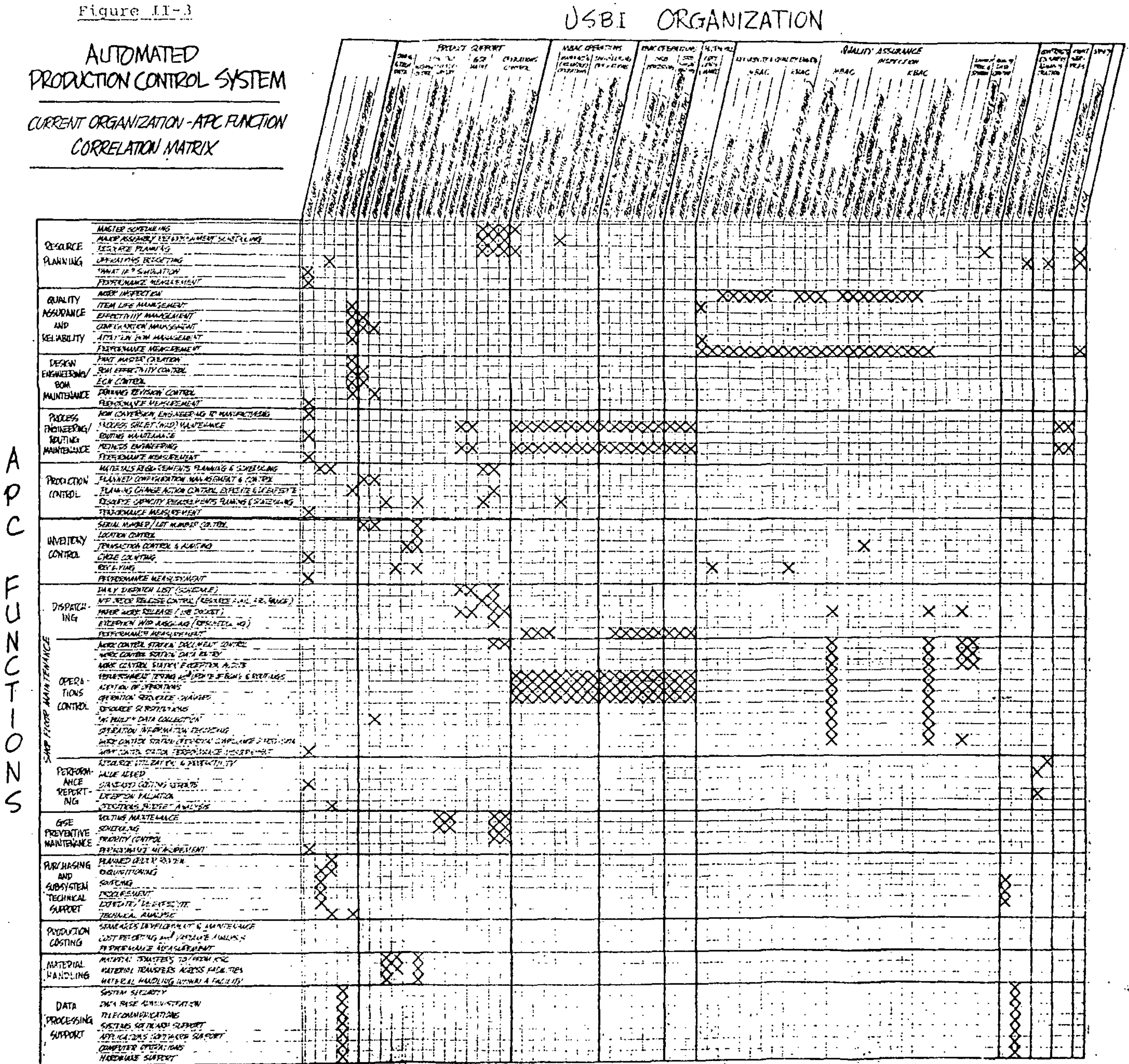
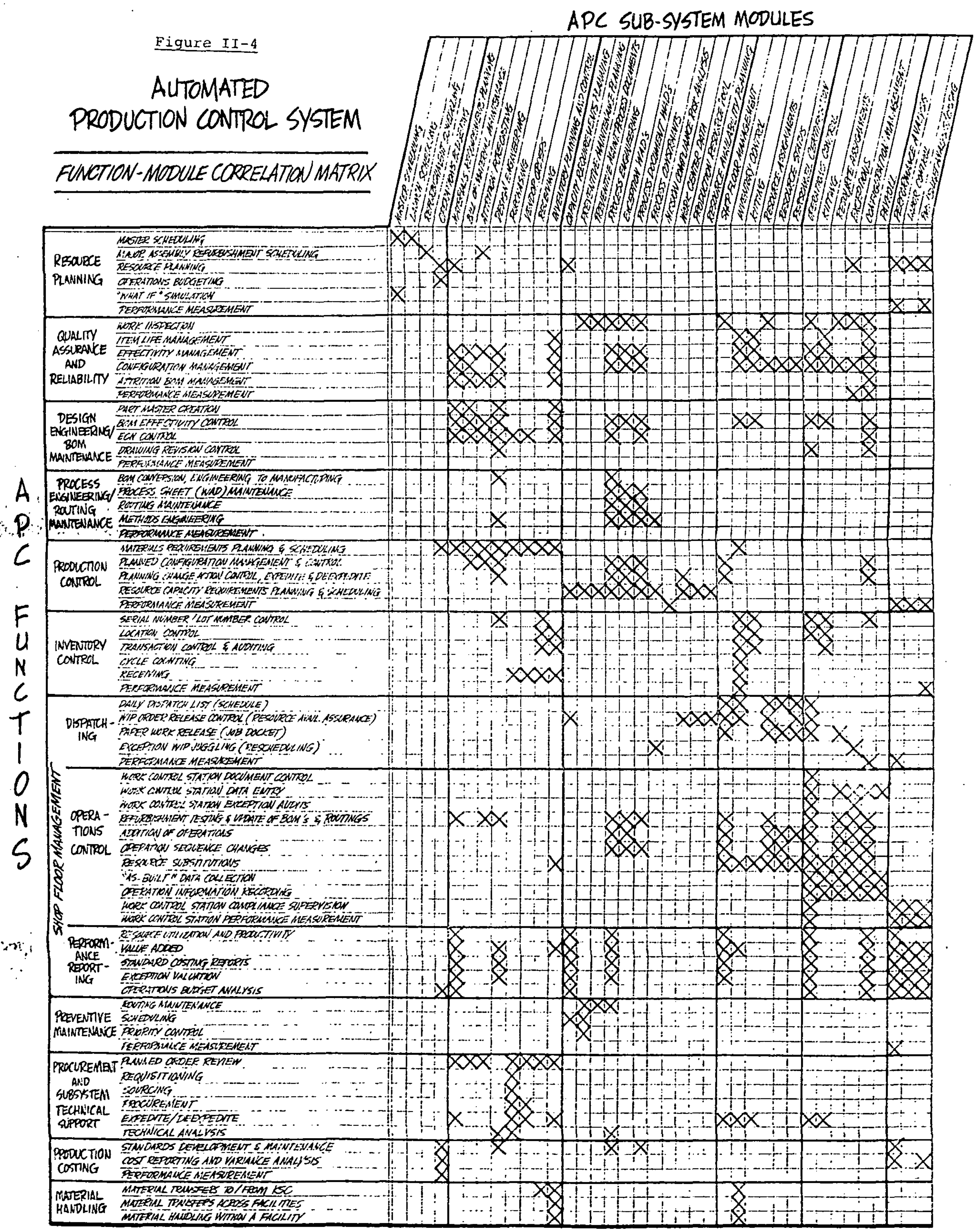


Figure II-4

AUTOMATED PRODUCTION CONTROL SYSTEM

FUNCTION-MODULE CORRELATION MATRIX



INITIAL MATERIAL ACQUISITION - USBI

° PROGRAM MGMT OFFICE – SENDS TO PROCUREMENT	PROGRAM MANAGER WRITES RPO	° NASA DEFINES REQUIREMENTS ° TIMING BASED ON POPS & SUBASS'Y WORK FLOWS ° CONSIDER ENGRG CHANGES
° PROCUREMENT – SENDS TO VENDOR	SOURCE, SOLICIT BIDS, EVALUATE & SELECT VENDOR, CUT P.O., EXPEDITE	
° VENDOR	VENDOR MANUFACTURES	
° VENDOR SHIPS TO KSC	SOURCE INSPECT (GREEN TAG)	° SOURCE INSPECTION BY RELIABILITY & QUALITY ASSURANCE • TECHNICAL SUPPORT BY PROGRAM MANAGER'S OFFICE (LIASON)
° KSC HANGAR ROAD	RECEIVED AT KSC 'BREAKBULK'	• ALL VENDORS' MATERIAL CLEARS
° HANGAR 'N'	RECEIVED BY USBI	• NOTIFY LOGISTICS (VAB) • FEEDBACK TO PURCHASING ° COUNT AGAINST PACKING SLIP ° COMPLETE RECEIVER ° ENTER INTO SIMS ° VENDOR DATA PACK TO QUALITY DATA CENTER
° HANGAR 'N'	INSPECTED	° INSPECT ACCORDING TO RII PER QUALITY ENGINEERING ° ISSUE PARTS TAG / ATTACH
• HANGAR 'N'	ACCEPTED	° INPUT ACCEPTANCE TO SIMS ° RECEIVER NOTED AS 'ACCEPTED' ° STORAGE LOCATION ° LOGISTICS
° HANGAR 'N'	STORED -1	° SEMI-LOCATOR SYSTEM ° EXCEPTIONS (E.G. LARGE ITEMS) REMAIN AT HANGAR 'N' UNTIL REQUIRED AT VAB
• VAB 1N4	STORED-2	° FIXED LOCATOR SYSTEM ° FIXED LOCATION

INITIAL MATERIAL ACQUISITION - USBI

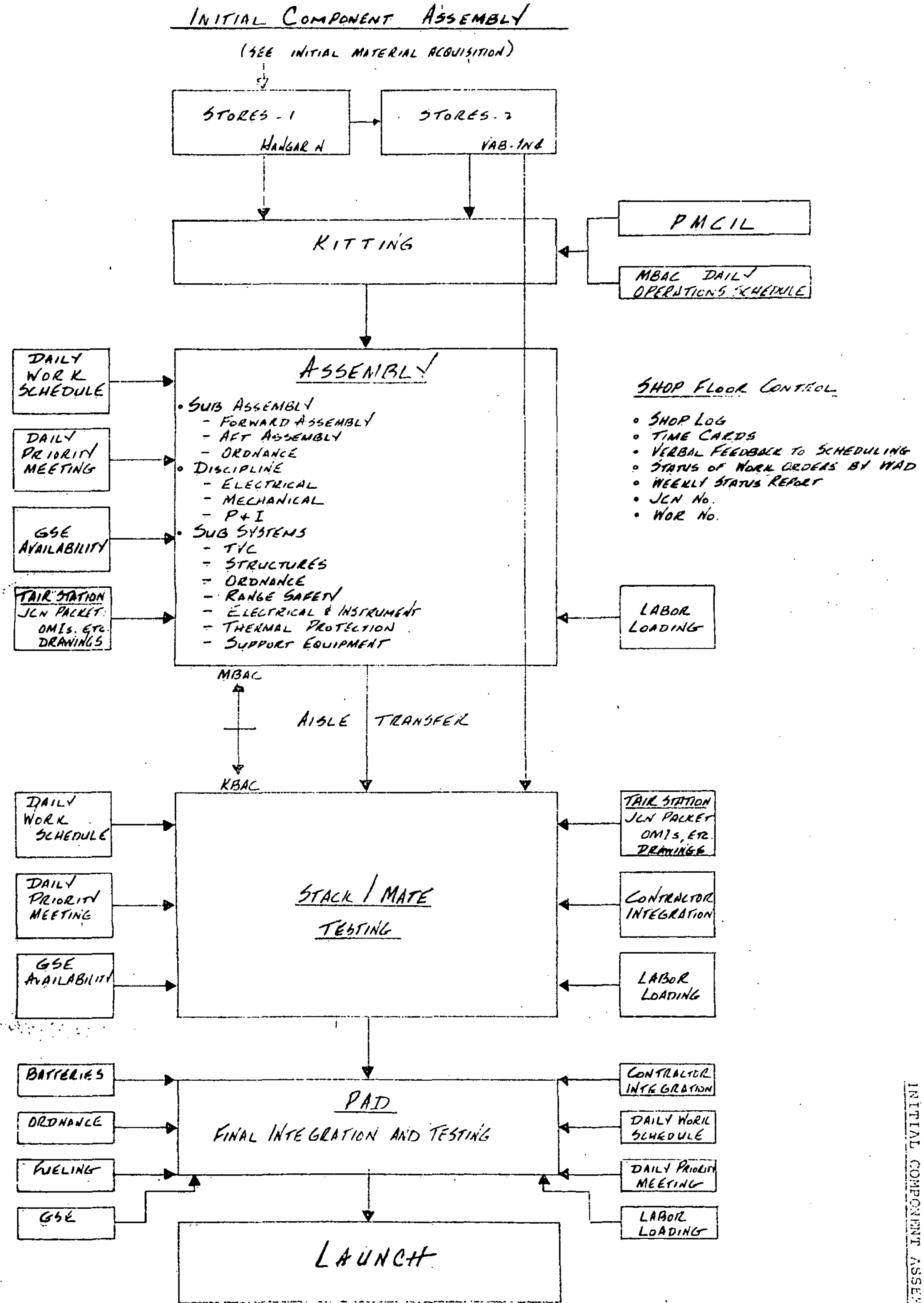


EXHIBIT II-2
INITIAL COMPONENT ASSEMBLY

REFURBISHMENT CYCLE — MATERIAL FLOWS

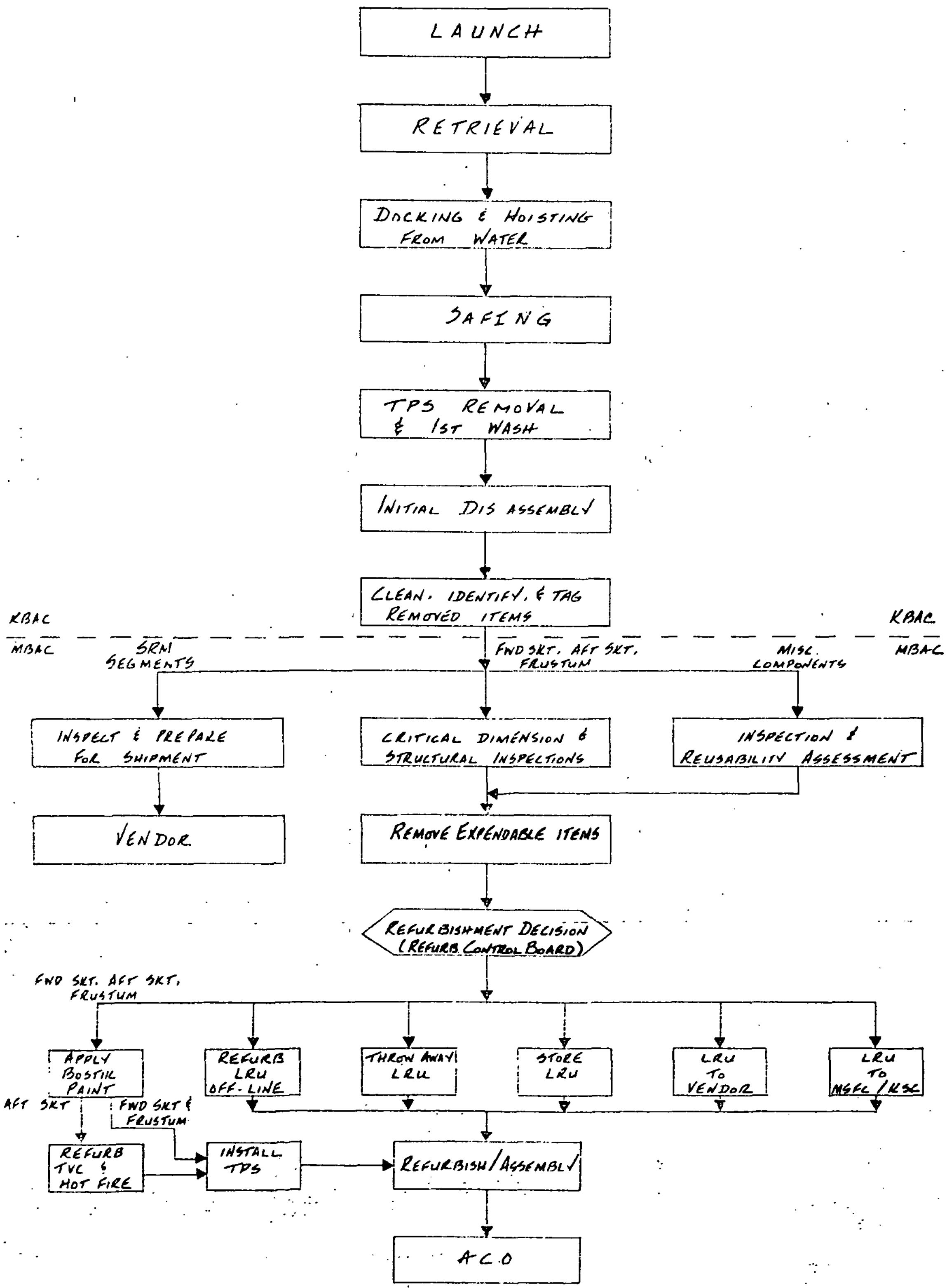


EXHIBIT II-3
REFURBISHMENT CYCLE - MATERIAL FLOWS